

Amendments to the Claims:

1. (currently amended) A storage virtualization computer system comprising:

a host entity for issuing IO requests;

an external storage virtualization controller coupled to said host entity for

5 executing IO operations in response to said IO requests; and

a group of physical storage devices (PSDs), each coupled to the external storage
virtualization controller through a point-to-point serial-signal interconnect,
for providing storage to the storage virtualization computer system through
the external storage virtualization controller;

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wherein said external storage virtualization controller comprises:

a central processing circuitry for performing said IO operations in response to
said IO requests of said host entity;

15 at least one IO device interconnect controller coupled to said central processing
circuitry;

at least one host-side IO device interconnect port provided in one of said at least
one IO device interconnect controller for coupling to said host entity; and

20 at least one device-side IO device interconnect port provided in one of said at least
one IO device interconnect controller for coupling to said group of PSDs through
said point-to-point serial-signal interconnect, said device-side IO device
interconnect port being a serial port for point-to-point serial-signal transmission;

wherein said computer system further comprises a detachable canister attached to said
external storage virtualization controller for containing one of said PSDs therein;

25 wherein said external storage virtualization controller is configured to define at least
one logical media unit consisting of sections of said group of PSDs; and

wherein said external SVC issues a device-side IO request to said IO device
interconnect controller, and said IO device interconnect controller re-formats said
device-side IO request and accompanying IO data into at least one data packet for
30 transmission to said group of PSDs through said device-side IO device interconnect

port; and

wherein a new PSD can be attached to said external storage virtualization controller
when said external storage virtualization controller is on-line. ~~said data packet~~
~~comprises a start segment at the beginning indicating the start of said data packet, an~~
5 ~~end segment at the end indicating the end of the data packet, a payload data segment~~
~~containing actual IO information to transmit through the device-side IO device~~
~~interconnect, and a check data segment containing check codes derived from said~~
~~payload data for checking the correctness of said payload data after transmission.~~

10 2. (original) The storage virtualization computer system of claim 1 wherein said
point-to-point serial-signal interconnect is a Serial ATA IO device interconnect.

3. (previously presented) The computer system of one of claims 1 and 2,
wherein said group of PSDs comprises a SATA PSD.

15 4. (previously presented) The computer system of one of claims 1 and 2,
wherein said group of PSDs comprises a PATA PSD and a serial-to-parallel converter
is provided between one of said device-side IO device interconnect port and said
PATA PSD.

20 5. (cancelled)

6. (currently amended) The computer system of one of claims 1 and 2,
wherein one of said PSDs can be detached from said external storage virtualization
25 controller when said external storage virtualization controller is on-line.

7-9. (cancelled)

10. (previously presented) The storage virtualization computer system of
30 claim 1 wherein one of said host-side IO device interconnect port and one of said

device-side IO device interconnect port are provided in a same IO device interconnect controller.

11. (previously presented) The storage virtualization computer system of
5 claim 1 wherein said at least one IO device interconnect controller comprises a plurality of IO device interconnect controllers; wherein one of said host-side IO device interconnect port and one of said device-side IO device interconnect port are provided in different IO device interconnect controllers.

10 12. (currently amended) The computer system of one of claims 1 and 2, wherein said external storage virtualization controller comprises a plurality of host-side IO device interconnect ports each for coupling to a host-side IO device interconnect.

15 13. (currently amended) The computer system of claim 12, wherein said external storage virtualization controller is configured to present redundantly a logical media unit on at least two of said plurality of host-side IO device interconnect ports.

14. (previously presented) The computer system of claim 1, wherein at least
20 one said host-side IO device interconnect port is Fibre Channel supporting point-to-point connectivity in target mode.

15. (previously presented) The computer system of claim 1, wherein at least one
25 said host-side IO device interconnect port is Fibre Channel supporting private loop connectivity in target mode.

16. (previously presented) The computer system of claim 1, wherein at least
one said host-side IO device interconnect port is Fibre Channel supporting public loop connectivity in target mode.

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17. (previously presented) The computer system of claim 1, wherein at least one said host-side IO device interconnect port is parallel SCSI operating in target mode.

5 18. (previously presented) The computer system of claim 1, wherein at least one said host-side IO device interconnect port is ethernet supporting the iSCSI protocol operating in target mode.

10 19. (previously presented) The computer system of claim 1, wherein at least one said host-side IO device interconnect port is Serial-Attached SCSI (SAS) operating in target mode.

15 20. (previously presented) The computer system of claim 1, wherein at least one said host-side IO device interconnect port is Serial ATA operating in target mode.

21. (currently amended) A storage virtualization subsystem for providing storage to a host entity, comprising:
an external storage virtualization controller for connecting to the host entity and
executing IO operations in response to IO requests issued from said host
20 entity; and
a group of physical storage devices (PSDs), each coupled to the external storage virtualization controller through a point-to-point serial-signal interconnect, for providing storage to the host entity through the external storage virtualization controller;

25 wherein said external storage virtualization controller comprises:

a central processing circuitry for performing said IO operations in response to said IO requests of said host entity;
30 at least one IO device interconnect controller coupled to said central processing

circuitry;

at least one host-side IO device interconnect port provided in one of said at least one IO device interconnect controller for coupling to said host entity; and

at least one device-side IO device interconnect port provided in one of said at least one IO device interconnect controller for coupling to said group of PSDs through said point-to-point serial-signal interconnect, said device-side IO device interconnect port being a serial port for point-to-point serial-signal transmission;

wherein said subsystem further comprises a detachable canister attached to said external storage virtualization controller for containing one of said PSDs therein;

wherein said external storage virtualization controller is configured to define at least one logical media unit consisting of sections of said group of PSDs; and

wherein said external SVC issues a device-side IO request to said IO device interconnect controller, and said IO device interconnect controller re-formats said device-side IO request and accompanying IO data into at least one data packet for transmission to said group of PSDs through said device-side IO device interconnect port; and

~~wherein said data packet comprises a start segment at the beginning indicating the start of said data packet, an end segment at the end indicating the end of the data packet, a payload data segment containing actual IO information to transmit through the device side IO device interconnect, and a check data segment containing check codes derived from said payload data for checking the correctness of said payload data after transmission.~~

22. (original) The storage virtualization subsystem of claim 21 wherein said point-to-point serial-signal interconnect is a Serial ATA IO device interconnect.

23. (cancelled)

24. (previously presented) The storage virtualization subsystem of claim 21

wherein one of said host-side IO device interconnect port and one of said device-side IO device interconnect port are provided in a same IO device interconnect controller.

25. (previously presented) The storage virtualization subsystem of claim
5 21 wherein said at least one IO device interconnect controller comprises a plurality of IO device interconnect controllers; wherein one of said host-side IO device interconnect port and one of said device-side IO device interconnect port are provided in different IO device interconnect controllers.

10 26. (previously presented) The storage virtualization subsystem of claim 21, wherein said group of PSDs comprises a SATA PSD.

27. (currently amended) The storage virtualization subsystem of claim 21,
15 wherein said external storage virtualization controller comprises a plurality of host-side IO device interconnect ports each for coupling to a host-side IO device interconnect.

28-29. (cancelled)

20 30. (previously presented) The storage virtualization subsystem of claim 21, wherein said group of PSDs comprises a PATA PSD and a serial-to-parallel converter is provided between one of said device-side IO device interconnect port and said PATA PSD.

25 31. (cancelled)

32. (currently amended) The storage virtualization subsystem of claim 21,
wherein one of said PSDs can be detached from said external storage virtualization controller when said external storage virtualization controller is on-line.

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33. (currently amended) The storage virtualization subsystem of claim 21, wherein said a new PSD can be attached to said external storage virtualization controller when said external storage virtualization controller is on-line.

5 34. (currently amended) The storage virtualization subsystem of claim 21, wherein said group of PSDs include a first set of PSDs and a second set of PSDs, said first set of PSDs and said second set of PSDs are not received in a same enclosure, and said external storage virtualization controller further comprises at least one multiple-device device-side expansion port for coupling to said second set of said
10 PSDs.

35. (previously presented) The storage virtualization subsystem of claim 21, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting point-to-point connectivity in target mode.
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36. (previously presented) The storage virtualization subsystem of claim 21, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting private loop connectivity in target mode.

20 37. (previously presented) The storage virtualization subsystem of claim 21, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting public loop connectivity in target mode.

38. (previously presented) The storage virtualization subsystem of claim 21,
25 wherein at least one said host-side IO device interconnect port is parallel SCSI operating in target mode.

39. (previously presented) The storage virtualization subsystem of claim 21, wherein at least one said host-side IO device interconnect port is ethernet supporting
30 the iSCSI protocol operating in target mode.

40. (previously presented) The storage virtualization subsystem of claim 21, wherein at least one said host-side IO device interconnect port is Serial-Attached SCSI (SAS) operating in target mode.

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41. (previously presented) The storage virtualization subsystem of claim 21, wherein at least one said host-side IO device interconnect port is Serial ATA operating in target mode.

10 42. (previously presented) The storage virtualization subsystem of claim 21 further comprising an enclosure management services mechanism.

43. (original) The storage virtualization subsystem of claim 42, wherein said enclosure management services mechanism manages and monitors at least one of the
15 following devices belonging to the storage virtualization subsystem: power supplies, fans, temperature sensors, voltages, uninterruptible power supplies, batteries, LEDs, audible alarms, PSD canister locks, door locks.

44. (original) The storage virtualization subsystem of claim 42, wherein said
20 enclosure management services mechanism is configured to support direct-connect EMS configuration.

45. (original) The storage virtualization subsystem of claim 42, wherein said enclosure management services mechanism is configured to support device-forwarded
25 EMS configuration.

46. (original) The storage virtualization subsystem of claim 42, wherein said enclosure management services mechanism is configured to support direct-connect EMS configuration and device-forwarded EMS configuration.

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47. (original) The storage virtualization subsystem of claim 42, wherein said enclosure management services mechanism is configured to support SES enclosure management services protocol.

5 48. (original) The storage virtualization subsystem of claim 42, wherein said enclosure management services mechanism is configured to support SAF-TE enclosure management services protocol.

10 49. (currently amended) The storage virtualization subsystem of claim 42, wherein said EMS mechanism further comprises I2C latches to communicate with said external storage virtualization controller.

15 50. (currently amended) The storage virtualization subsystem of claim 42, wherein said EMS mechanism further comprises status-monitoring circuitry to communicate with said external storage virtualization controller.

20 51. (currently amended) The storage virtualization subsystem of claim 42, wherein said EMS mechanism further comprises the following mechanism to communicate with said external storage virtualization controller: I2C latches and status-monitoring circuitry.

52. (original) The storage virtualization subsystem of claim 42, wherein said EMS mechanism further comprises a CPU for running a program.

25 53. (currently amended) The storage virtualization subsystem of claim 42, wherein said EMS mechanism further comprises at least one I2C interconnect as a primary communication media to said external storage virtualization controller.

30 54. (withdrawn) An external storage virtualization controller for executing IO operations in response to IO requests from a host entity, comprising:

a central processing circuitry for performing IO operations in response to said IO requests of said host entity;
at least one IO device interconnect controller coupled to said central processing circuitry;
5 at least one host-side IO device interconnect port provided in a said at least one IO device interconnect controller for coupling to said host entity; and
at least one device-side IO device interconnect port provided in a said at least one IO device interconnect controller for coupling to and performing point-to-point serial-signal transmission with at least one physical storage
10 device.

55. (withdrawn) The external storage virtualization controller of claim 54 wherein said device-side IO device interconnect controller comprises at least one Serial ATA port, each for connecting to a said at least one physical storage device
15 through a Serial ATA IO device interconnect.

56. (withdrawn) The external storage virtualization controller of one of claims 54 and 55 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in the same IO device interconnect
20 controller.

57. (withdrawn) The external storage virtualization controller of one of claims 54 and 55 wherein a said host-side IO device interconnect port and a said device-side IO device interconnect port are provided in different IO device interconnect
25 controllers.

58. (withdrawn) The external storage virtualization controller of one of claims 54 and 55 wherein said device-side IO device interconnect controller further comprises a PCI/PCI-X interface for connecting to the central
30 processing circuit.

59. (withdrawn) The external storage virtualization controller of one of claims 54 and 55 wherein said device-side IO device interconnect controller further comprises a PCI Express interface for connecting to the central processing circuit.

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60. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein said storage virtualization controller comprises a plurality of host-side IO device interconnect ports each for coupling to a host-side IO device interconnect.

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61. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein said storage virtualization controller is configured for defining at least one logical media unit consisting of sections of said at least one PSD.

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62. (withdrawn) The external storage virtualization controller of claim 60, wherein said storage virtualization controller is configured for presenting redundantly a logical media unit on at least two of said plurality of host-side IO device interconnect ports.

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63. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said PSD is a direct-access storage device (DASD) and said storage virtualization controller is configured for defining a logical media unit consisting of sections of at least one said direct access storage device and said logical media unit is of RAID level or a combination of RAID levels, whereby said logical media unit is contiguously addressable by said host entity.

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64. (withdrawn) The external storage virtualization controller of one of claims 54 and 55 further comprising at least one multiple-device device-side expansion port for accommodating a second set of at least one PSD.

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65. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting point-to-point connectivity in target mode.

5 66. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting private loop connectivity in target mode.

10 67. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is Fibre Channel supporting public loop connectivity in target mode.

15 68. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is parallel SCSI operating in target mode.

20 69. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is ethernet supporting the iSCSI protocol operating in target mode.

70. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is Serial-Attached SCSI (SAS) operating in target mode.

25 71. (withdrawn) The external storage virtualization controller of one of claims 54 and 55, wherein at least one said host-side IO device interconnect port is Serial ATA operating in target mode.

30 72. (withdrawn) The external storage virtualization controller of one of claims 54 and 55 further comprising an enclosure management services mechanism.

73. (withdrawn) The storage virtualization controller of claim 72, wherein said enclosure management services mechanism is configured to support direct-connect EMS configuration.

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74. (withdrawn) The storage virtualization controller of claim 72, wherein said enclosure management services mechanism is configured to support device-forwarded EMS configuration.

10 75. (withdrawn) The storage virtualization controller of claim 72, wherein said enclosure management services mechanism is configured to support direct-connect EMS configuration and device-forwarded EMS configuration.

15 76. (withdrawn) The storage virtualization controller of claim 72, wherein said storage virtualization controller is configured to support SES enclosure management services protocol.

20 77. (withdrawn) The storage virtualization controller of claim 72, wherein said storage virtualization controller is configured to support SAF-TE enclosure management services protocol.

78. (currently amended) A method for performing storage virtualization in a computer system with an external storage virtualization controller of the computer system, the method comprising:

25 receiving, by the external storage virtualization controller, an IO request from a host entity of the computer system;
parsing, by the external storage virtualization controller, the IO request to decide at least one IO operation to perform in response to said IO request;
performing, by the external storage virtualization controller, at least one IO
30 operation to access a group of physical storage devices (PSDs) of the

computer system in point-to-point serial-signal transmission; and
performing said at least one IO operation by a central processing circuitry in the
external storage virtualization controller in response to said IO request of
said host entity;

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wherein said external storage virtualization controller includes:

at least one IO device interconnect controller coupled to said central processing
circuitry;

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at least one host-side IO device interconnect port provided in one of said at least
one IO device interconnect controller for coupling to said host entity; and

at least one device-side IO device interconnect port provided in one of said at least
one IO device interconnect controller for coupling to said group of PSDs through
said point-to-point serial-signal interconnect, said device-side IO device
interconnect port being a serial port for point-to-point serial-signal transmission;

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wherein said computer system further comprises a detachable canister attached to said
external storage virtualization controller for containing one of said PSDs therein;
wherein said external storage virtualization controller is configured to define at least
one logical media unit consisting of sections of said group of PSDs;

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wherein said external SVC issues a device-side IO request to said IO device
interconnect controller, and said IO device interconnect controller re-formats said
device-side IO request and accompanying IO data into at least one data packet for
transmission to said group of PSDs through said device-side IO device interconnect
port; and

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wherein said group of PSDs include a first set of PSDs and a second set of PSDs, said
first set of PSDs and said second set of PSDs are not received in a same enclosure, and
said external storage virtualization controller further comprises at least one
multiple-device device-side expansion port for coupling to said second set of said
PSDs.

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~~wherein said data packet comprises a start segment at the beginning indicating the~~

5 ~~start of said data packet, an end segment at the end indicating the end of the data packet, a payload data segment containing actual IO information to transmit through the device side IO device interconnect, and a check data segment containing check codes derived from said payload data for checking the correctness of said payload data after transmission.~~

79. (original) The method of claim 78 wherein the point-to-point serial-signal transmission is performed in a format complying with a Serial ATA protocol.

10 80. (original) The method of one of claims 78 and 79 further comprising the step of providing an enclosure management services mechanism.

81. (original) The method of claim 80 further comprising the step of executing said enclosure management services mechanism when said mechanism is configured
15 to support direct-connect EMS configuration.

82. (original) The method of claim 80 further comprising the step of executing said enclosure management services mechanism when said mechanism is configured to support device-forwarded EMS configuration.

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83. (original) The method of claim 80 further comprising the step of executing said enclosure management services mechanism when said mechanism is configured to support direct-connect EMS configuration and device-forwarded EMS configuration.

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84. (currently amended) The method of claim 80 further comprising the step of executing said enclosure management services mechanism when said external storage virtualization controller is configured to support SES enclosure management services protocol.

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85. (currently amended) The method of claim 80, further comprising the step of executing said enclosure management services mechanism when said external storage virtualization controller is configured to support SAF-TE enclosure management services protocol.

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86. (previously presented) The method of one of claims 78 and 79, wherein said group of PSDs comprises a SATA PSD.

87. (previously presented) The method of one of claims 78 and 79, wherein
10 group of PSDs comprises a PATA PSD and serial signals in said serial signal transmission are converted by a serial-to-parallel converter to parallel signals compliant with said PATA PSD.

88-89. (cancelled)

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90. (currently amended) A computer-readable storage medium having a computer program code stored therein that is capable of causing a computer system having an external storage virtualization controller and a group of physical storage devices (PSDs) connected to the storage virtualization controller to perform the steps
20 of:

receiving, by the external storage virtualization controller, an IO request from a host entity of the computer system;

parsing, by the external storage virtualization controller, the IO request to decide at least one IO operation to perform in response to said IO request;

25 performing said at least one IO operation with the external storage virtualization controller to access said group of PSDs in point-to-point serial-signal transmission; and

performing said at least one IO operation by a central processing circuitry in the external storage virtualization controller in response to said IO request of
30 said host entity;

wherein said external storage virtualization controller includes:

5 at least one IO device interconnect controller coupled to said central processing
 circuitry;

 at least one host-side IO device interconnect port provided in one of said at least
 one IO device interconnect controller for coupling to said host entity; and

 at least one device-side IO device interconnect port provided in one of said at
10 least one IO device interconnect controller for coupling to one of said
 PSDs through said point-to-point serial-signal interconnect, said
 device-side IO device interconnect port being a serial port for
 point-to-point serial-signal transmission;

wherein said computer system further comprises a detachable canister attached to said
external storage virtualization controller for containing one of said PSDs therein;

15 wherein said external storage virtualization controller is configured to define at least
 one logical media unit consisting of sections of said group of PSDs; and

 wherein said external SVC issues a device-side IO request to said IO device
 interconnect controller, and said IO device interconnect controller re-formats said
 device-side IO request and accompanying IO data into at least one data packet for
20 transmission to said group of PSDs through said device-side IO device
 interconnect port; and

wherein the external storage virtualization controller is configured to present
redundantly a logical media unit on at least two of said plurality of host-side IO
device interconnect ports.

25 ~~wherein said data packet comprises a start segment at the beginning indicating the~~
~~start of said data packet, an end segment at the end indicating the end of the data~~
~~packet, a payload data segment containing actual IO information to transmit~~
~~through the device side IO device interconnect, and a check data segment~~
~~containing check codes derived from said payload data for checking the~~
30 ~~correctness of said payload data after transmission.~~

91. (original) The computer-readable storage medium of claim 90 wherein the point-to-point serial-signal transmission is performed in a format complying with a Serial ATA protocol.

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92. (previously presented) The computer-readable storage medium of one of claims 90 and 91, wherein said group of PSDs comprises a SATA PSD.

93. (previously presented) The computer-readable storage medium of one of
10 claims 90 and 91, wherein said group of PSDs comprises a PATA PSD and serial signals in said serial signal transmission are converted by a serial-to-parallel converter to parallel signals compliant with said PATA PSD.

94-96. (cancelled)

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97. (previously presented) The storage virtualization computer system of claim 1, wherein said group of PSDs are received in a plurality of enclosures.

98. (previously presented) The storage virtualization subsystem of claim 21,
20 wherein said group of PSDs are received in a plurality of enclosures.

99. (previously presented) The method of claim 78, wherein said group of PSDs are received in a plurality of enclosures.

25 100. (previously presented) The computer-readable storage medium of claim 90, wherein said group of PSDs are received in a plurality of enclosures.

101. (currently amended) The storage virtualization computer system of claim 1, wherein said group of PSDs include a first set of PSDs and a second set of PSDs, said
30 first set of PSDs and said second set of PSDs are not received in a same enclosure, and

said external storage virtualization controller further comprises at least one multiple-device device-side expansion port for coupling to said second set of said PSDs.

5 102. (cancelled)

103. (currently amended) The computer-readable storage medium of claim 90, wherein said group of PSDs include a first set of PSDs and a second set of PSDs, said first set of PSDs and said second set of PSDs are not received in a same enclosure, and
10 said external storage virtualization controller further comprises at least one multiple-device device-side expansion port for coupling to said second set of said PSDs.